A field test of the food frequency interview was made in a heterogeneous sample of pregnant women in Jerusalem. The authors discuss the limitations and possible uses of the food frequency interview and conclude that this method merits consideration in epidemiological studies as a simple and economical tool, even though it is not very sharp.

FOOD FREQUENCY INTERVIEW AS AN EPIDEMIOLOGICAL TOOL

J. H. Abramson, M.B., B.Ch.; C. Slome, M.B., Ch.B., D.P.H.; and Chava Kosovsky

IT IS desirable that the dietary information gathered in an epidemiological study should be as full and accurate a record of the diet of the individual subjects as is possible and necessary. An accurate record is, however, far from easy to achieve, particularly when the aim is a picture of the characteristic diet over a longer period than a single day, week, or month. Apart from the expense in time and trained personnel of detailed quantitative studies, it may be very difficult to get both accuracy and the usual picture.[1,2] "The value of dietary studies of the individual's actual current intakes for short periods—one day, one week, or even one month—is questionable for most epidemiological purposes, unless there is good indication that the short-term studies reflect usual eating patterns of the past."[1]

Thomson[3] has concluded that "There is, at present, no completely satisfactory field technique that can be applied on a large scale, and it is doubtful whether one will ever be devised." In this impasse, he recommends the use of detailed quantitative methods, stating "Some sort of result may be obtained from most subjects, with methods that avoid measurement; but large numbers of inaccurate estimates are no substitute at all for a few accurate measurements." This conclusion is, however, debatable if the use of accurate data results in a sampling bias, as it may tend to do. In Thomson's own detailed study of Aberdeen primigravidae, the percentage of women for whom apparently reliable data could be obtained fell from 93 per cent in his highest social group to 61 per cent in his lowest. Dietary studies in Israel have demonstrated the same difficulty. In one, in which women were interviewed about their diet on three separate days, Guggenheim, et al.,[4] found that although they obtained records from most of their 164 subjects, only 100 appeared to be reliable. In another, in which concurrent dietary records were kept for a fortnight, Bavly[5] found that even though the subjects were selected on the basis of their "cooperation, understanding and truthfulness," 10 per cent of the records had to be rejected.

For these and other reasons, it has

been suggested that simple interview methods be tested in an effort to find a practical means for classifying individuals according to their dietary practices, rather than according to the amounts of specific nutrients in their diets.[2,6]

One method which has been used for this purpose is the food frequency interview, i.e., an interview on the usual intake, in terms of the frequency with which various food items are taken. As Wiehl and Reed[6] have said, "If groups of individuals can be clearly differentiated by use or nonuse, frequent or infrequent use of selected foods . . . then such characteristics can be tested for association with disease."

The present report deals with a small-scale field test of the food frequency method carried out during a three-week period in June-July, 1961, in the course of a community program (directed by Dr. Sidney L. Kark) for the study and control of anemia in pregnant women in Jerusalem, Israel. The aim was two-fold: first, to see whether the frequency with which specific foods were taken was a reasonable index of the usual quantity of these foods eaten per week, both sets of data being obtained by interview; and second, to test the value of the method empirically, by seeking associations between the frequency data and the subjects' hemoglobin levels. It was not possible to obtain quantitative dietary data by actual measurement for comparison with the frequency data. The reliability of the method, that is the extent to which a repeated interview provided similar information to the first, was not tested.

Sample and Method

The sample was comprised of 60 Jewish women, aged from 17 to 39, in the fifth to eighth months of pregnancy who were receiving antenatal care from two community health centers of the Hadassah Medical Organization. The aim was a heterogeneous rather than a representative sample. Heterogeneity would, it was thought, weight the chances against finding high correlations between frequency and quantity, on the assumption that the more variable the backgrounds of the subjects, the more variable would be their food practices, including the size of their usual servings. Of the 60 women, 32 had been born outside Israel—18 in five Asian countries, 11 in four African countries, and three in three European countries; 28 had been born in Israel—13 of them Ashkenazi, five Sephardi, and ten of Asian origin. In Israel such differences as these tend to be associated with dietary differences.[7]

Each subject was questioned by the same interviewer (C.K.) about her usual diet during the previous three months. The interviews took about 30 minutes on the average. Questions were asked about both frequency and amounts in respect to the following items: bread and rolls, milk as a beverage, milk added to other beverages, milk added to other foods, sour-milk preparations, poultry, meat, liver, fish (except herring), herring, eggs, citrus fruit, fruit or vegetable juice, dried fruit, 15 specified green/yellow vegetables, and tomatoes. Also, questions about frequency only were asked in respect to macaroni and similar foods, cakes, nine specified cereals, cheese, ice cream, cream, butter or margarine, 21 specified fruits, nuts, seven other vegetables (not green or yellow), olives, chocolate, halva (a sesame or peanut product), peanut butter, and t'hina (a sesame product). In addition to these questions about individual items, frequency data were obtained for the following groups of foods: flesh foods (meat, poultry, fish), green/yellow vegetables, and fresh fruit.

Frequency was recorded in two ways: (a) the number of times the food was taken per week; and (b) the number of

days per week. Where a single figure was not given, as narrow a range as possible was obtained; if the range exceeded one, its mid-point was used. The categories used were: never taken; taken less than one time or day a week; one; one to two; two; two to three; and so on. The usual weekly quantities were estimated as carefully as possible by the use of household measures and samples of food. Amounts were recorded in gm or ml, except for eggs, where the number of eggs was used.

Hemoglobin values were extracted from the health center records, the first result in the current pregnancy being taken. The tests were performed in a single laboratory with a standardized technic. In the analyses only the 49 tests performed in the second trimester of pregnancy were used. The values ranged from 9.9 to 15.0 gm per cent, with a median of 11.9.

In testing the associations between frequency and quantity data, Kendall's rank correlation coefficient (tau) was used, with allowance for tied ranks.[8] The Mann-Whitney U test was used in comparing the groups shown in Table 2.[9] Associations with hemoglobin levels were tested with Armsen's tables.[10]

Results

Frequency Compared with Quantity

For most of the separate food items tested there was a moderate or high correlation between the number of times the food was usually taken per week and the weekly amount. Most of the correlation coefficients (tau) were over 0.8 (column A, Table 1). The values for milk, eggs, and most vegetables were high, and those for poultry, meat, fish, and citrus were moderate. The lowest value was that for bread and rolls (0.42). When the women who never took the food were excluded, the tau values were lower but still significant; in most cases the drop did not exceed 0.2 (column B, Table 1).

The findings suggested that variations in the size of average servings of most foods did not outweigh the effects of differences in frequency. As servings were not actually measured, such findings might result from undue standardization in the estimation of their size, and this may partly explain the correlations found. Care was taken, however, to make individualized estimates; the records revealed a considerable range of variation in the sizes of the average servings estimated for different women, even for items with high tau values. Thus, the estimated amount of milk taken as a beverage by different women varied from 100 to 400 ml per occasion; that of fruit juice from 100 to 300 ml; that of green peppers from 14 to 200 gm; and that of green maize from 75 to 250 gm.

The alternative record of food frequency, i.e., the number of days the food was taken per week, tended to relate less strongly with quantity, particularly where many subjects took the food more often than once a day. Thus, for green peppers, which only four women ate more than once a day, tau dropped only from 0.91 to 0.84; whereas for tomatoes, which 36 women took more than once a day, the drop was from 0.58 to 0.32. Accordingly, in what follows only the data on the number of times per week will be referred to.

Correlations between frequency and estimated quantity were lower for groups of foods than for separate items. For the group of green/yellow vegetables, tau was 0.38, and for flesh foods (poultry, meat, fish, excluding liver) it was 0.48. Apart from these findings, each of which was based on the answer to a single direct question about the group as a whole, combined frequencies were calculated by adding the separate frequencies of each item in the group. For green/yellow vegetables, this combined frequency gave a tau of 0.59 when tested against the quantity data; for flesh foods, tau was 0.48; and for the milk group (fresh

Table 1—Coefficients of Correlation (tau) Between Number of Times Food Is Taken Per Week and Estimated Weekly Intake

	A*	B*	Median Weekly Amount†
Milk			
As beverage	0.89	0.81 (46)	1,775 ml
Added to other beverages	0.86	0.56 (33)	700 ml
Added to other foods	0.93	—	—
Sour-milk preparations	0.86	0.80 (50)	635 ml
Eggs	0.95	0.95 (57)	7 eggs
Flesh Foods			
Poultry	0.57	0.41 (51)	360 gm
Meat	0.74	0.61 (49)	210 gm
Fish (excluding herring)	0.66	0.57 (54)	250 gm
Herring	0.99	—	—
Liver (poultry or beef)	0.91	0.70 (34)	50 gm
Bread and Rolls	0.42	0.42 (60)	1,572 gm
Fruit and Vegetables			
Citrus	0.56	0.38 (51)	2,100 gm
Dried fruit	0.94	—	—
Fruit or vegetable juice	0.96	0.90 (34)	1,400 ml
Tomato	0.58	0.58 (59)	1,050 gm
Green/yellow vegetables:‡			
Cucumber	0.63	0.59 (58)	1,000 gm
Lettuce	0.72	0.61 (49)	500 gm
Green maize	0.94	0.86 (38)	300 gm
Green pepper	0.91	0.86 (48)	280 gm
Squash	0.80	0.59 (42)	200 gm
Carrot	0.91	0.73 (32)	150 gm
Green beans	0.76	0.39 (40)	150 gm
Green peas	0.96	0.56 (28)	100 gm
Cabbage	0.96	0.78 (20)	72 gm
Mangold ("pazi")	0.96	—	—
Soup greens	0.95	—	—

All the above values for tau are highly significant (P=0.001 or less).

* A. Tau value for all subjects. B. Tau value for only the subjects who take the food (number stated in parentheses); value not stated if food is taken by under 20 women.

† For subjects taking the food.

‡ Excluding spinach, sweet potatoes, and sweet red peppers, which were eaten by seven, three, and two women, respectively, and pumpkin, which no woman ate more than "occasionally."

and sour milk), 0.55. In addition, weighted combined frequencies were calculated by adding the separate frequencies of component items, after weighting them in accordance with the mean size of the servings of each. For flesh foods, this gave a tau of only 0.43; but for the milk group, one of 0.75. It was concluded that, in this sample, the indexes correlating best with the quantitative data were: for green/yellow vegetables, the combined frequency; for flesh foods, the response to the direct question; and for milk, the weighted combined frequency. Although the coefficients were not high, it was possible by using each of these indexes to divide the 60 subjects into three subgroups with significant dif-

ferences in the amounts of these foods taken weekly (Table 2).

Frequency and Hemoglobin Levels

The weekly frequency of only one separate item, namely dried fruit, bore a significant association with hemoglobin levels. In view of the large number of associations tested, this was considered a negligible finding. When the data for groups of foods were tested, no significant relationships were found, although certain trends were apparent.

However, when combinations of the frequency data for various groups of foods were tested, a number of significant relationships emerged. These combinations were, in a measure, expressions of the subjects' over-all diets. The food groups taken were flesh foods, the milk group, green/yellow vegetables, and fresh fruit (combined frequency). Subjects with a "high" intake (above the median value) of any two or more of these groups tended to have "high" hemoglobin values (above 11.8 gm per cent, i.e., at or above the median value). There were 14 women with high-frequency figures for both milk and fruit; of these, 11 had high hemoglobin levels ($P<0.05$). There were 19 with high figures for milk and either fruit and/or green/yellow vegetables; of these, 15 had high hemoglobin levels ($P<0.01$). Of seven women with high figures for flesh foods, milk and fruit, all had high

Table 2—Estimated Quantities Taken by Subjects, Grouped on Basis of Frequency with Which Three Food-Groups Are Taken

	No. of Women	Mean Weekly Quantity	P*
Meat, Poultry, Fish†			
Low frequency	22	418 gm	
			<0.01
Intermediate frequency	20	870 gm	
			<0.01
High frequency	18	1,206 gm	
Milk, Sour Milk‡			
Low frequency	20	1,402 ml	
			<0.001
Intermediate frequency	20	2,926 ml	
			<0.001
High frequency	20	4,146 ml	
Green/Yellow Vegetables§			
Low frequency	20	1,708 gm	
			<0.01
Intermediate frequency	19	3,020 gm	
			<0.001
High frequency	20	4,680 gm	

* Significance of differences in quantities taken.

† As measured by response to a direct question. "Low"=six or fewer times a week, "high"=over eight.

‡ Weighted combined frequency (see text). Weighting: respective frequencies for milk as beverage, for milk added to beverages, for milk added to other foods, and for sour milk, multiplied by ten, three, six, and eight (on basis one point=approximately 20 ml per week). "Low"=up to 110 points; "high"=174 points or over.

§ Combined frequency (see text). "Low"=up to 24 times a week; "high"=over 32 times. Incomplete data for one subject.

hemoglobin levels ($P<0.01$); of eight with high figures for flesh foods, milk and vegetables, seven had high hemoglobin levels ($P<0.05$); and of ten with high figures for flesh foods, milk and either fruit or vegetables, nine had high hemoglobin levels ($P<0.05$). There were 26 subjects with high figures for either flesh foods, or milk, and also for either fruit or vegetables; of these, 17 had high hemoglobin levels ($P<0.05$).

Discussion

The findings confirm both the limitations and the possible uses of the food frequency interview. In this purposely chosen heterogeneous sample, it gave a fairly similar picture of the usual consumption of most individual foods to that given by a more laborious interview about the amounts usually consumed. In more homogeneous samples, with little variation in their dietary practices, the similarity would possibly be closer. The similarity in this sample was not close enough to justify the choice of this method in studies of the diet of individuals, but it was close enough to warrant its consideration in the comparison of moderately sized groups in an epidemiological study. That is, it could be considered both in studies where the group is the statistical unit (e.g., in comparing samples with different mean hemoglobin levels) and in those where the individual is the statistical unit (e.g., where the subjects are grouped according to their individual hemoglobin levels).

It was not possible to test the method against a more objective standard, such as data based on long-term or repeated individual dietary studies using measured quantities and analyzed foods. Such validity tests may show that the responses to the frequency interview are so influenced by the subject's recollection of his diet during the past week or fortnight and by other subjective factors that they are a poor reflection of the usual diet. On the other hand, it may be that, at least in some populations, this method can provide as useful a picture of the usual diet as do some more laborious methods. The frequency data may be of a higher order of accuracy, although more limited, than quantitative data obtained by means other than measurement. Numerous studies have shown the possible inaccuracy of estimates of portion sizes[1,3,11] and the inaccuracies implicit in the usual methods of calculating nutrients.[12,13]

The main limitation of the method is, of course, its inability to provide data on individual nutrients. Although differences may be shown in dietary practices, they cannot lead to definite conclusions about the existence, nature, or size of nutrient differences. Different food patterns may give similar intakes of nutrients.[14,15] Even where common sense suggests conclusions in terms of nutrients, for example where an association has been shown between gum lesions and the infrequent consumption of fruit,[16] such conclusions can be only speculative. Frequency data for groups of foods, which might lead to more meaningful hypotheses concerning nutrients than can similar data for separate items, tended in this sample to be less strongly correlated with the quantitative data.

However, the relationships found between hemoglobin levels and various combinations of the frequency data for different groups of foods support the value of this method in demonstrating an association between diet and a health state. Although, without a more representative sample and the due consideration of other variables, no conclusions could be drawn about an association between hemoglobin levels and diet among pregnant women in Jerusalem, the finding empirically supported the usefulness of this method as an epidemiological tool. Studies in various populations have provided similar evidence of the value of food frequency data. Associations

have been shown, for example, with anemia,[17] the physique of schoolboys,[18] serum protein levels,[19] rheumatic fever,[20] and various mucocutaneous signs of malnutrition.[21]

Apart from its relative ease, the food frequency method has a possible advantage in that under certain circumstances, information about food patterns, per se, may be as useful as that about nutrients. It has been suggested that studies of intake in terms of food items may suggest important relationships with cardiovascular disease.[2]

Practical Implications

It is clear that the main use of this method in epidemiological studies is as a simple and economical tool—not very sharp, but adequate for some purposes—for detecting differences between the usual diets of groups of subjects. It will indicate only whether the usual food patterns are similar, but will not indicate the nature of differences in terms of nutrients. It may, however, suggest more detailed dietary hypotheses for testing by other methods.

The method should therefore continue to be considered where evidence is sought of an association with diet in general, rather than with specific nutrients. It may be of particular use in the "clue-seeking" stage of a study. It may also be of use in studies of associations with nondietary variables as an indicator of the comparability of subgroups in respect of diet. For such purposes it may suffice to inquire into the use of selected foods only. Such an inquiry should possibly incorporate other simple questions, for example, on the usual amounts of some foods where there is reason to believe that this information will be readily and reasonably accurately obtained; this may apply to such foods as eggs and milk.

Where simple and economical methods of detecting differences in usual diet between groups are being sought, the main choice appears to lie between the food frequency interview (or other simple interview methods, as suggested by Wiehl and Reed[6]) and the 24-hour record or recall. The latter methods, in spite of their low validity as measures of the usual diet of individuals, may provide a satisfactory indication of the mean current intake of groups,[11] and under certain circumstances may provide a useful guide to the usual intake of a group. In choosing between these methods, practical points in favor of the frequency method, which may outweigh its limitations, are its simplicity and the avoidance of a need to convert the data to nutrient intake. The best practical solution may be the use of both the frequency interview and the 24-hour record recall. Comparative tests of the validity of these methods as measures of intergroup differences against more objective baselines would be of value.

In occasional studies where an association is suspected between a specific food and a health state (e.g., between eggs and rheumatic fever[20]), the frequency interview may have special advantages. Occasionally, too, frequency itself will enter into the hypothesis, as in studies of the relationship between dental caries and the frequency of food taken between meals.[22] The method may also be used in planning and evaluating a dietary education program and as a stimulus to nutrition education.[23] Also it has a possible role as a case-finding tool in nutritional programs by picking out persons who are most likely to need more detailed dietary investigation and treatment.

It would be unwise to decide on the use of this method without a prior field test in the community to be studied. In interpreting the findings, due account should be taken of seasonal variation; this may be a limiting factor in the use of the method where marked seasonal changes occur.

Summary

A field test of the food frequency interview was performed in a heterogeneous sample of pregnant women in Jerusalem. The subjects were questioned about their usual diet during the previous three months in terms of the frequency and quantity of various foods. For most of the separate foods, there was a moderate or high correlation between the number of times the food was usually taken per week and the estimated amount usually taken weekly. For groups of foods there was a lower correlation with estimated amounts. There were significant relationships between the subjects' hemoglobin levels and various combinations of the food frequency data.

The limitations and possible uses of the food frequency interview are discussed. It is concluded that the method continues to merit consideration in epidemiological studies as a simple and economical—although not very sharp—tool for detecting differences between the usual food patterns of groups of subjects. It may be of particular use in the "clue-seeking" stage of an epidemiological study or as an indicator of the comparability of subgroups in respect to diet.

ADDENDUM. A British study, which came to our attention after this report had been written, has shown that it may be possible, by developing a suitable scoring system, to make use of food frequency data to classify persons by their intake of specific nutrients.[24,25]

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Dr. Abramson is and Dr. Slome (at the time of this study) was a visiting senior lecturer, Department of Social Medicine, Hadassah University Hospital and Hebrew University-Hadassah Medical School, Jerusalem. Dr. Slome is now associate professor of epidemiology, University of North Carolina, Chapel Hill, N. C. Miss Kosovsky is a graduate public health nurse, Hadassah University Hospital, Jerusalem.